A Model-based approach to Motion Control design

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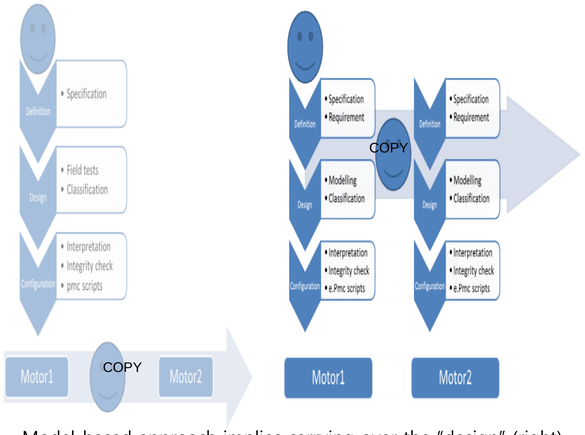
Design/Deployment cycle

Model-based Motion control design and implementation for Delta Tau PMAC® systems has provided:

- Quick, reliable and straightforward transition from Spec/Requirements to design and to configuration
- Trouble free, quick and yet reliable deployment and setup for “simple” stepper applications
- Predictable and reliable motion control design and tuning for challenging applications like in-vacuum motors, closed-loop tracking axes, and scanners with velocity requirements
- The design process is documented within the model itself
- Easily scalable to other platforms
- Architecture enables ongoing development while still supporting existing deployments
- The approach is being extended to provide "standard solutions" for specific "classes" of stages

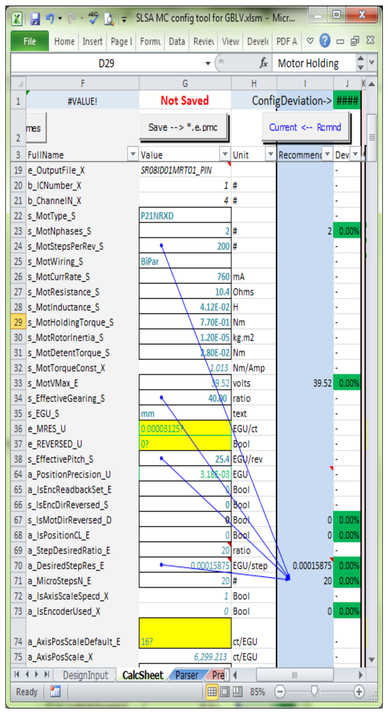


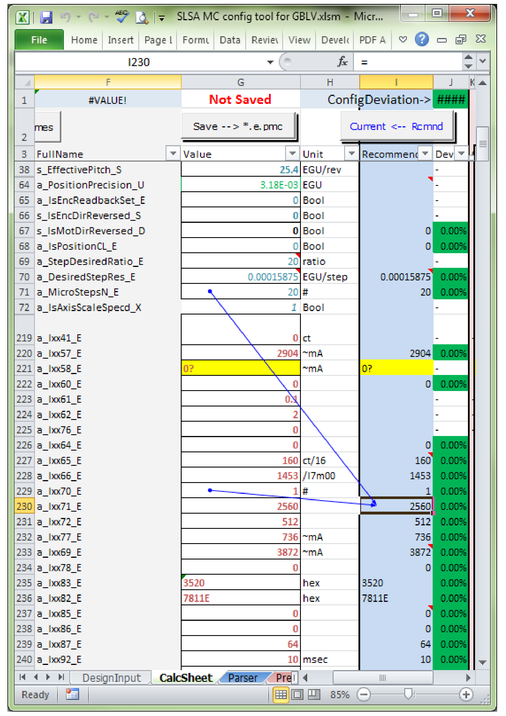
Model-based approach implies carrying over the “design” (right) instead of copying “configuration” (left) along for similar applications. Tools are provided both for design analysis and for fast generating hardware specific configurations out of designs.

Implementation

X-model is implemented using Excel spreadsheet features and VB macros

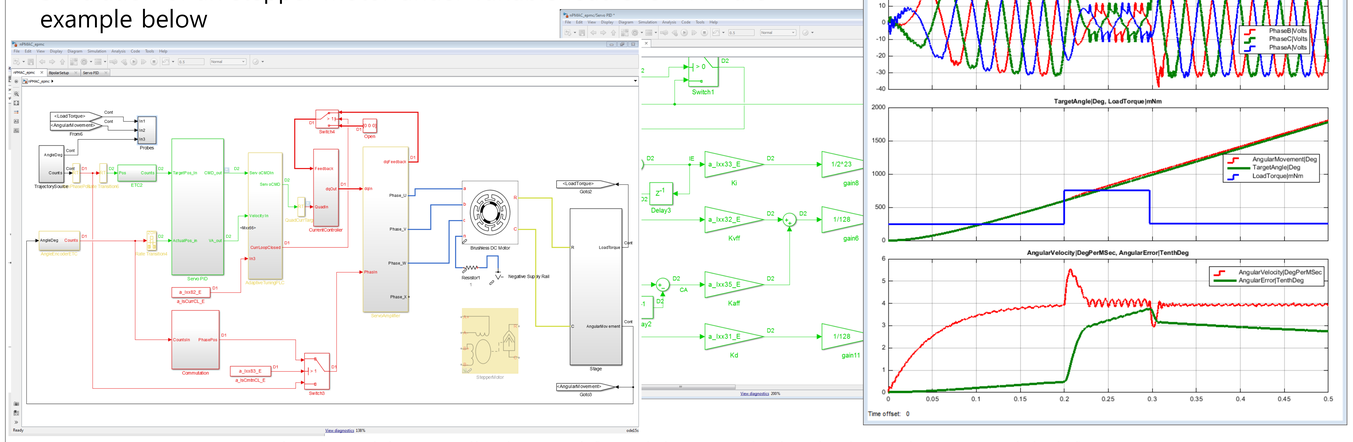
- The X-model encapsulates Design inputs, Specifications, Engineering inputs and hardware specific information and static formulations
- Using an interactive process, motion control parameters will be determined from spec /requirements (left)
- Then system configuration will be formed based on motion control parameters (right)
- The whole design/configuration information is then saved in "extended pmac" script files, directly downloadable to GBLV. This files serves as the reference for axis configuration information.





M-model is implemented in MATLAB®, using Simulink®/ Simscape®

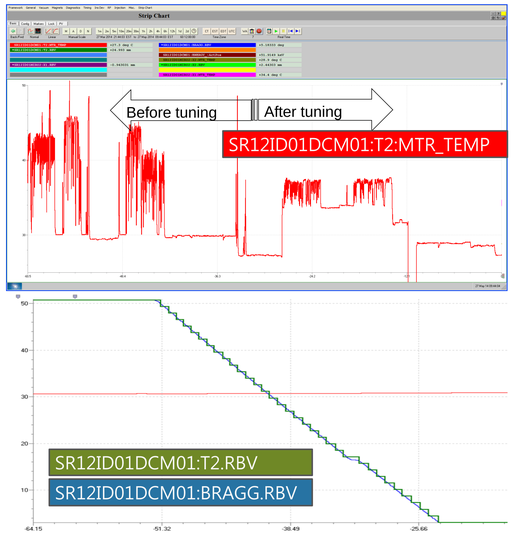
- Dynamic model of Stage, Motor, Controller, Encoders, Sensors and maybe, the experiment
- Model parameters directly imported from the "extended pmac" script file
- Iterative tuning of parameters is done using simulation
- Simulation of an stepper motor under variable load shown in the example below



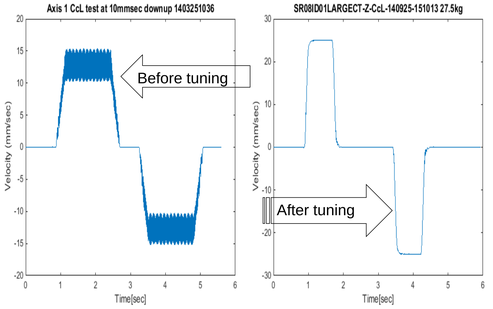
The GeoBrick controller is tuned for minimum Velocity ripples, using M-Model. (left)
Simulation of load disturbance rejection at 0.2sec on Z Wedge scanner with Brushless DC motor (right)

Beamline outcomes

More than 80 motion stages in XAS, IMBL, SXR and XFM beamlines are designed, configured and tuned efficiently utilizing the tools and the process



Model-based tuning utilized to achieve tracking performance in closed loop (bottom), with temperature constraints for in-vacuum DCM - T2 stage at XAS. Motor temperature is maintained in the desired 30-40C range after tuning (top)



Model-based tuning (right) helped improving all performance indexes significantly, from conventional tuning (left) for the challenging Large CT scanner stage at IMBL.

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